Elective Endovascular vs. Open Repair for Abdominal Aortic Aneurysm in Patients Aged 80 Years and Older: Systematic Review and Meta-Analysis

F. Biancari a,*, A. Catania b, V. D’Andrea b

a Division of Cardio-thoracic and Vascular Surgery, Department of Surgery, Oulu University Hospital, P.O. Box 21, Oulu 90029, Finland
b Department of Surgical Sciences, La Sapienza University, Rome, Italy

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Abstract

Objectives: Endovascular treatment (EVAR) of abdominal aortic aneurysm (AAA) is thought to be of benefit, particularly in patients aged ≥80 years. This issue was investigated in the present meta-analysis.

Design: The study design involved a systematic review of the literature and meta-analysis.

Methods: Systematic review of the literature and meta-analysis of data on elective EVAR vs. open repair of AAA in patients aged ≥80 years were performed.

Results: Six observational studies reporting on 13,419 patients were included in the present analysis. Pooled analysis showed higher immediate postoperative mortality after open repair compared with EVAR (risk ratio 3.87, 95% confidence interval (CI) 3.19–4.68; risk difference, 6.2%, 95% CI 5.4–7.0%). The pooled immediate mortality rate after open repair was 8.6%, whereas it was 2.3% after EVAR. Open repair was associated with a significantly higher risk of postoperative cardiac, pulmonary and renal complications. Pooled analysis of three studies showed similar overall survival at 3 years after EVAR and open repair (risk ratio 1.10, 95% CI 0.77–1.57).

Conclusions: The results of this meta-analysis suggest that elective EVAR in patients aged ≥80 years is associated with significantly lower immediate postoperative mortality and morbidity than open repair and should be considered the treatment of choice in these fragile patients. These results indicate also that, when EVAR is not feasible, open repair can be performed with acceptable immediate and late survival in patients at high risk of aneurysm rupture.

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Keywords

Abdominal aortic aneurysm;
Octogenarian;
Nonagenarian;
Endovascular;
Open repair
The Hippocratic Oath states: "I will prescribe regimen for the good of my patients according to my ability and my judgement and never do harm to anyone". This phrase reminds us the need to continually ask ourselves whether any vascular procedures we perform are truly indicated and associated with a clear benefit for our patients. This applies particularly to patients with high operative risk and a short life expectancy such as those aged \( \geq 80 \) years. The decision-making process in this fragile patient population must take into account the finite nature of life, the extent of the procedure and the severity of its related potential complications other than mortality. Indeed, patients may survive a major operation but may become bedridden or severely depressed, or experience a severe impairment of quality of life. Therefore, the decision whether or not to perform a major surgical procedure in the very elderly requires a sufficient burden of evidence regarding its potentially associated harms and benefits. These issues assume even major importance as population projects indicate that the number of persons aged \( \geq 80 \) years will double during the next 20 years. Along with patients’ age, there will be an increased need of major surgery, such as elective repair of abdominal aortic aneurysm (AAA), to prevent aneurysm rupture and the associated high mortality in the very elderly. Because of its minimally invasive nature, endovascular treatment of AAA (EVAR) is thought to be of particular benefit, particularly in octogenarians and nonagenarians. This study was planned to quantify the benefit of EVAR compared with open repair in the very elderly in short-term and assess its benefit in the long term.

**Materials and Methods**

An English-language literature review was performed through PubMed, Scopus, Science Direct and Cochrane Library up to March 2011 for any study evaluating the immediate and late outcomes after elective repair for AAA in patients aged 80 years and older. The words employed in the search were "abdominal aortic aneurysm," "open repair," "endovascular," "EVAR," "endoluminal," "octogenarian," "nonagenarian" and "80 years." Reference lists of obtained articles were searched as well. This study was not financially supported.

**Inclusion criteria**

Prospective and retrospective observational studies published in English language as full-length article and reporting on the outcome of patients aged 80 years and older who underwent elective repair for AAA were considered for this analysis. Only studies comparing open repair and EVAR in such patients were considered for inclusion. Studies including repair for rupture of AAA were excluded. Similarly, we excluded from the analysis patients who underwent repair for symptomatic AAA, as their immediate mortality is higher than that of patients with asymptomatic AAA. The language of the articles was defined as reported in PubMed and Scopus. We did not include in this study unpublished data or data reported only in abstract. We applied the guidelines for Meta-analysis of Observational Studies in Epidemiology (MOOSE).

**Data collection and assessment of data quality**

The investigators identified the articles potentially dealing with this topic, abstracted data from all eligible studies using a standardised Excel file, retrieved data on study design, study size, patient demographics, types of intervention and 30-day/in-hospital as well as late outcome. Data were retrieved only from the articles, and no attempt to get missing data from the authors was made.

The quality of observational, cohort studies was assessed by use of the Newcastle–Ottawa scale, which is a nine-point scale that assigns points on the basis of the process of selection (0–4 points), comparability (0–2 points) and identification of the outcomes of study participants (0–3 points) in cohort studies (http://www.ohri.ca/programs/clinical_epidemiology/oxford.htm). In this study, data only on the immediate postoperative survival were not considered enough for an appropriate evaluation of the real benefits of these interventions. Therefore, the length of the follow-up period was considered to be sufficient only when at least 1-year overall survival data were reported in the retrieved study.

**Outcomes of interest**

The main outcome end point of this study was immediate and late all-cause mortality after AAA repair. Immediate postoperative mortality was defined as any death occurring during the in-hospital stay or the 30-day postoperative period. Secondary outcome end points were immediate postoperative cardiac, cerebrovascular, pulmonary, intestinal, renal and infectious complications. Data on immediate and late graft failure requiring re-intervention were retrieved as well.

**Statistical analysis**

Statistical analysis was performed using Review Manager 5.1 software (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2011) and Meta-analyst Beta 3.13 software (http://tuftscaes.org/meta_analyst/). The pooled risk of adverse event was expressed as risk ratio (RR) with 95% confidence interval (CI) and as risk difference with 95%CI. Because heterogeneity was anticipated in these observational studies, it was assessed a priori by a random effects model (DerSimonian–Laird). In this study, we did not perform meta-regression because of the small number of studies available for this meta-analysis.

We calculated the hazard ratios and 95% CIs from the survival curves of individual studies using a graphical approach that showed time trends. We considered 3 years as the late survival outcome measure, as we estimated that the mean follow-up period of retrieved studies ranged from 2 to 3 years. The natural logarithm of hazard ratio and of the estimated standard error of EVAR vs. open repair of each study were entered in to Review Manager to estimate pooled late survival by generic inverse variance analysis. Late pooled overall survival rates were estimated and plotted at different study intervals. A \( P < 0.05 \) was considered statistically significant.
Results

Literature search

The literature search performed in January 2011 yielded 56 articles, of which 11 were found to be pertinent to this topic (Fig. 1). After full-article review, three studies were excluded because they included patients with symptomatic AAA or urgent/emergency procedures. Lack of specific data on the outcome of patients aged 80 years and older was the reason for the exclusion of two studies.

Six studies were found to report data of interest and fulfilled the inclusion criteria of the present study. Table 1 summarises their main characteristics. The data quality of these studies as assessed by the Ottawa–Newcastle scale is summarised in Table 2.

Quality of the studies included in this analysis

None of the six studies available for the present analysis fulfilled all the Newcastle–Ottawa quality criteria (Table 2). In fact, besides the lack of data on late survival outcome in three studies, the lack of comparability between the study groups can be considered the major potential source of bias of these studies. Schermerhorn et al. reported the results on 22,830 propensity score-matched pairs including also patients aged <80 years; therefore, this study may also suffer from lack of comparability.

Immediate postoperative outcome

Pooled analysis of six studies showed higher immediate postoperative mortality after open repair compared with EVAR (RR 3.87, 95%CI 3.19–4.68; risk difference, 6.2%, 95% CI 5.4–7.0%) (Fig. 2). After excluding the study by Schermerhorn et al., which included the largest number of patients, open repair was still associated with significantly higher immediate postoperative mortality (RR 2.93, 95% CI 2.05–4.18).
The pooled immediate mortality rate after open repair was 8.6% (95% CI 7.4–10.0%), whereas it was 2.3% (95% CI 1.7–3.2%) after EVAR. Reported data on postoperative morbidity were scarce (Table 3). However, open repair was associated with a significantly higher risk of postoperative cardiac, pulmonary and renal complications (Table 3). The risk of pulmonary complications was particularly higher after open repair.

Long-term outcome

No data on the rate of graft failure and re-intervention late after primary procedure were available for this analysis.

Three studies20–22 reported on late survival (Table 1). Pooled analysis showed similar overall survival at 3 years (1.10, 95% CI 0.77–1.57, Figs. 3 and 4). It is worth noting that the data on late outcome from the study by Schermerhorn et al.20 was retrieved from survival curves of patients aged ≥85 years and, thus, it might have underestimated the real late survival of patients aged ≥80 years.

Discussion

Elective repair of AAA in patients aged ≥80 years may not be harmless to the patients and their families, and this must be taken seriously into account in a sound surgical judgement. In his editorial, McKneally2 stated: "We are still learning how and when to place reasonable limits on our impulse to rescue all who might benefit from the dramatic technologies of contemporary surgery". These words remind us that any surgical treatment, even if of minimally invasive nature, may be associated with a certain risk of adverse outcome. Therefore, any aggressive treatment as well as any enthusiasm towards new minimally invasive technology should be tempered by adequate data on the real benefits and harms associated with it.

Herein, we attempted to estimate the possible benefit of elective EVAR over open repair for AAA in patients aged ≥80 years, as the only currently available treatment methods to prevent the dramatic consequences of aneurysm rupture. In fact, about one-third of patients aged 80 years and older reaching the hospital alive are treated conservatively,6 and open repair of ruptured AAA in these patients is associated with an estimated immediate postoperative mortality of 59%.5 The risk of aneurysm rupture is related to its size, and it may be appropriate to consider AAA repair only in patients aged ≥80 years and with an AAA at excessive risk of rupture. A study by Brown et al.23 assessing the risk of rupture in non-operated aneurysm indicated an annual rupture rate of 14.1% among men and 22.3% among women when the AAA diameter was larger than 60 mm. Lederle et al.24 estimated a probable aneurysm rupture risk at 2 years of 22.1% for AAA with a diameter of 55–59 mm, of 18.9% for AAA with a diameter of 60–69 mm and 43.4% for AAA with a diameter of ≥70 mm. Aziz et al.25 reported on the outcome of 111 patients with a mean age of 80 years and with untreated AAA. Rupture of AAA occurred in 27 patients (median time to rupture = 14 months), with one patient surviving an emergency repair.

Table 2: Newcastle–Ottawa quality assessment of observational studies included in this meta-analysis evaluating the outcome after endovascular vs. open repair of abdominal aortic aneurysm in patients aged 80 years and older.

<table>
<thead>
<tr>
<th>Study</th>
<th>Representativeness</th>
<th>Selection</th>
<th>Ascertainment of exposure</th>
<th>Outcome not present at start of study</th>
<th>Comparability</th>
<th>Assessment of outcome long enough</th>
<th>Adequacy of follow-up</th>
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<td>★</td>
<td>★</td>
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Figure 2: Forest plot showing the pooled risk ratio for immediate postoperative mortality after endovascular (EVAR) vs. open repair of abdominal aortic aneurysm in patients aged 80 years and older.
patients.25 These data suggest that the risk of death in 21 (62%) died of aneurysm rupture out of 34 deceased patients (16%) died of aneurysm rupture out of 31 deceased repair. A total of 39 patients died from unrelated illnesses. Among patients with an AAA diameter of 50–59 mm, five patients (16%) died of aneurysm rupture out of 31 deceased patients. Among 53 patients with an AAA diameter >60 mm, 21 (62%) died of aneurysm rupture out of 34 deceased patients.25 These data suggest that the risk of death in patients with AAA larger than 60 mm may significantly outweigh the risk of aneurysm repair-related death in patients with a reasonably long life expectancy. These potential benefits may particularly apply to EVAR, as it is associated with significantly lower immediate postoperative mortality and morbidity compared with open repair, as shown in the present meta-analysis. However, contrary to open repair which is a durable procedure,26 EVAR is associated with a significantly high risk of re-intervention,15 particularly in the very elderly.

A study by the European Collaborators on Stent/graft techniques for aortic aneurysm repair (EUROSTAR) investigators4 demonstrated that only three ruptures (0.4%) occurred after EVAR in octogenarians with a maximal aneurysm diameter of 62 mm during a follow-up period of 72 months. The risk of re-intervention and re-admission is higher after EVAR compared with open repair,15 particularly in very elderly patients. However, such a risk can be acceptable in octogenarians and nonagenarians, because of their very high operative risk at the time of primary procedure and the short time-exposure to the risk of graft failure.

Giles et al.15 reported a re-intervention rate of 12 per 100 person-year in patients aged >80 years compared with rates ranging from 4.9 to 6.9 in younger patients. Furthermore, any re-intervention after EVAR was associated with an overall 30-day mortality of 9.6%, ranging from 2.8% after minor endovascular re-intervention to 30.2% after repair for aneurysm rupture.15 As the risk of re-interventions is much lower after open repair,26 these observations may explain the loss of early survival advantage benefit soon after EVAR. Despite the limited number of studies available for this analysis, we have also observed only slightly higher survival rates after elective EVAR than open repair of AAA. Importantly, the significantly higher early survival rates are likely associated with a better quality of life of octogenarians with otherwise a short life expectancy. Such advantages of EVAR on the early outcome of the very elderly are even more evident when we consider that, in the large study by Schermerhorn et al.,21 among patients aged >80 years, about 85–91% of operative survivors after EVAR were discharged home compared with 57–68% of patients after open repair (P < 0.001).

The results of this meta-analysis can be affected by the observational nature of the included studies and by the lack...
of comparability of the study groups. Anatomy suitability was certainly a source of significant bias between the study groups, as it is certainly the main determining factor regarding whether to perform EVAR or not. Indeed, it may significantly influence also the decision whether to operate or not. We speculate that patients with high operative risk were possibly turned down any repair in case of unsuitable anatomy for EVAR, whereas patients with anatomy suitable for EVAR were treated with this minimally invasive treatment method. This may be one of the reasons for the attrition of the survival curves of the study groups. However, these findings suggest that EVAR should be considered the treatment of choice in the very elderly, at least because of markedly better immediate outcome and the likely better chances of prompt recovery.20

In conclusion, current data suggest that elective EVAR is associated with significantly lower immediate postoperative mortality and morbidity risk than open repair in patients aged $\geq 80$ years with AAA. EVAR and open repair are associated with similar late survival. A preoperative selection bias in disfavour of patients undergoing EVAR may explain such late results, despite marked difference in early mortality and morbidity. These results indicate also that, when EVAR is not feasible, open repair can be performed with acceptable immediate and late survival in patients aged $\geq 80$ years with an AAA at high risk of rupture.

Conflict of interest/funding

None declared.

References

3 Statistics Finland. http://www.stat.fi/.[accessed 03.10.10].